Earthquakes, grants and public expenditure: how municipalities respond to natural disasters

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Background

Italy is a country with a **high frequency of earthquakes** $\rightarrow$ economic consequences.

100 billion Euro spent just for the 5 largest earthquakes occurred between 1968 and 2002.

However, little is known on public expenditure response to natural disasters and recovery (Bevan and Cook, 2015).

Barone and Mocetti (2014): A tale of two earthquakes

Other studies generally focus on country-level effects or analyze single disasters.

What we do

1. We investigate the response of local government expenditure to natural disasters:
   - We exploit detailed data on expenditure and transfers from the univerese of Italian municipalities for a 16-year period (2000-2015) and
   - a large historic dataset on seismic events

2. We exploit variability in transfers to investigate flypaper effects (matching versus unconditional grants).

3. We investigate the asymmetric response to increasing and decreasing grants and between Northern and Southern municipalities.

Key findings

- Local government expenditure increases, driven by transfers, for about 12 years after a shock with a U-shape, then it regresses to pre-disaster levels.

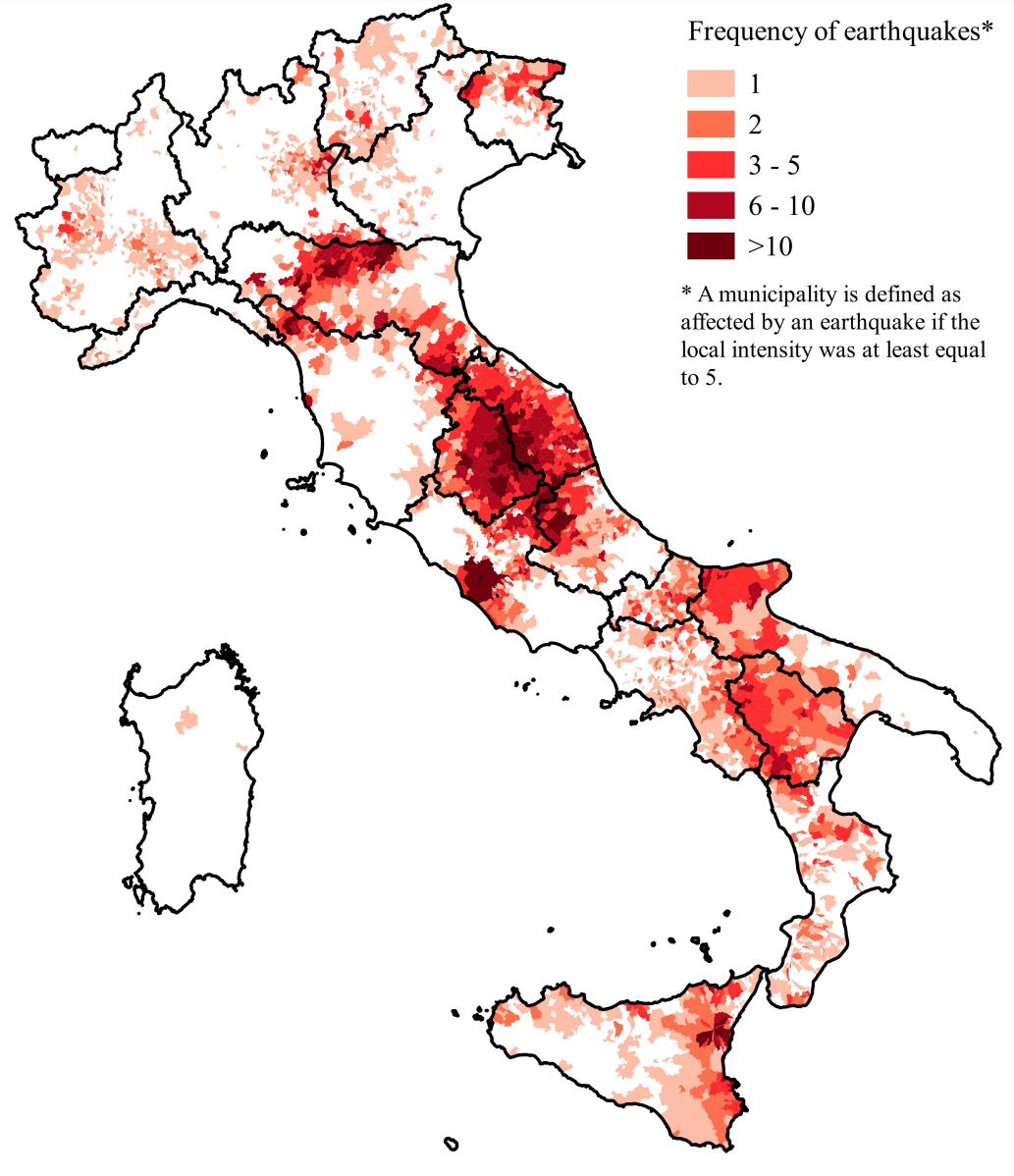
- We find evidence of flypaper effect and of an asymmetric response to decreasing grants for both earthquake-specific and unconditional grants.

- The reaction to earthquake-specific grants and the response provided by local governments differ strongly among Northern and Southern municipalities:
  - more inertia in the South;
  - quicker response and faster recovery in the North.

Outline

- Descriptive evidence
- Empirical strategy
  - Impact of earthquakes on spending levels
  - The role of grants
  - Heterogeneous and asymmetric flypaper effects
- Results
- The North-South divide
- Concluding remarks

Frequency and measurement of earthquake occurrence



The **Mercalli scale intensity** (I) measures observable effects.

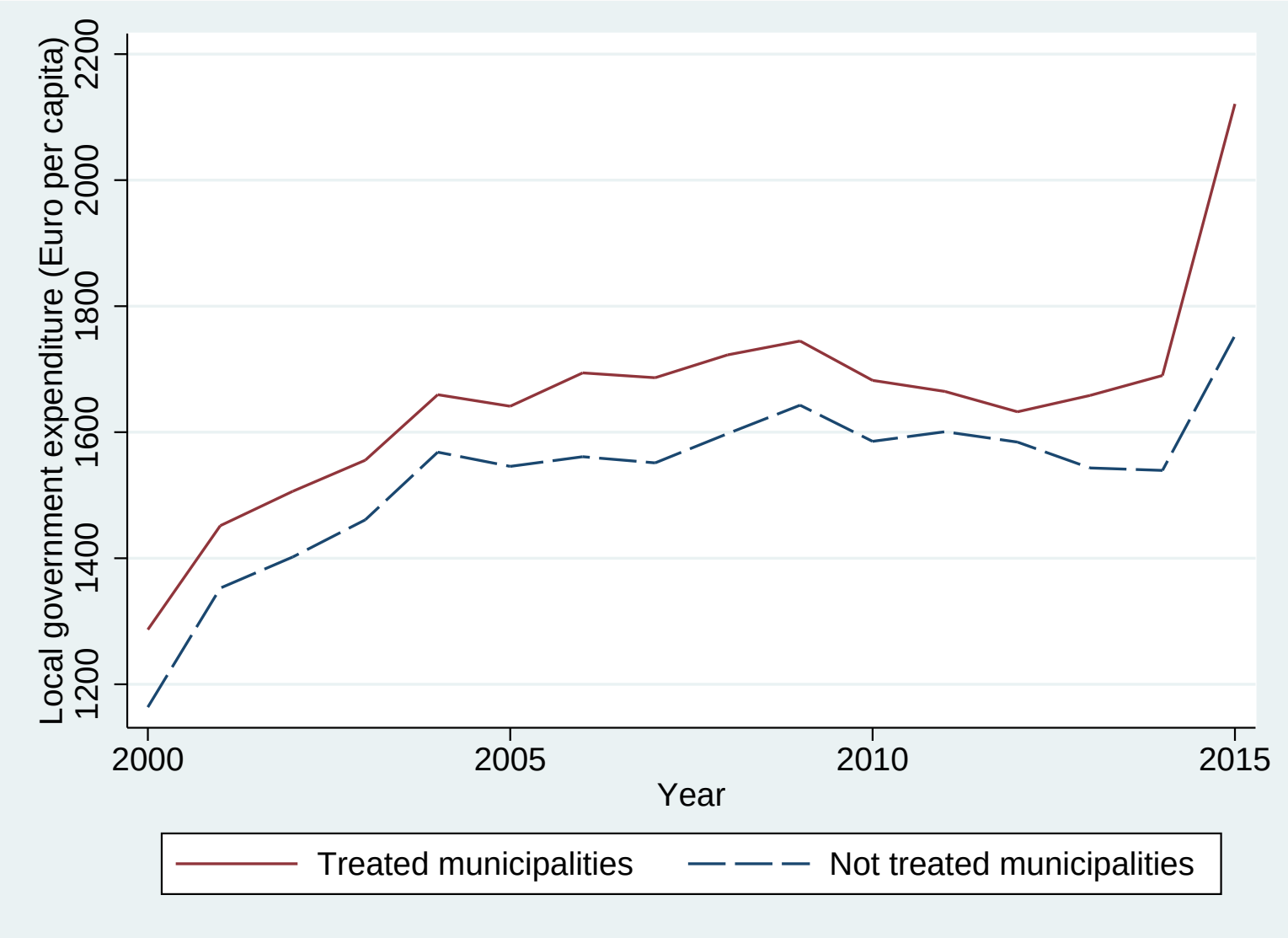
Damages to people and objects occur when $\mathbf{I \geqslant 5}$.

Since 1985, **one third of the municipalities** faced at least one earthquake.

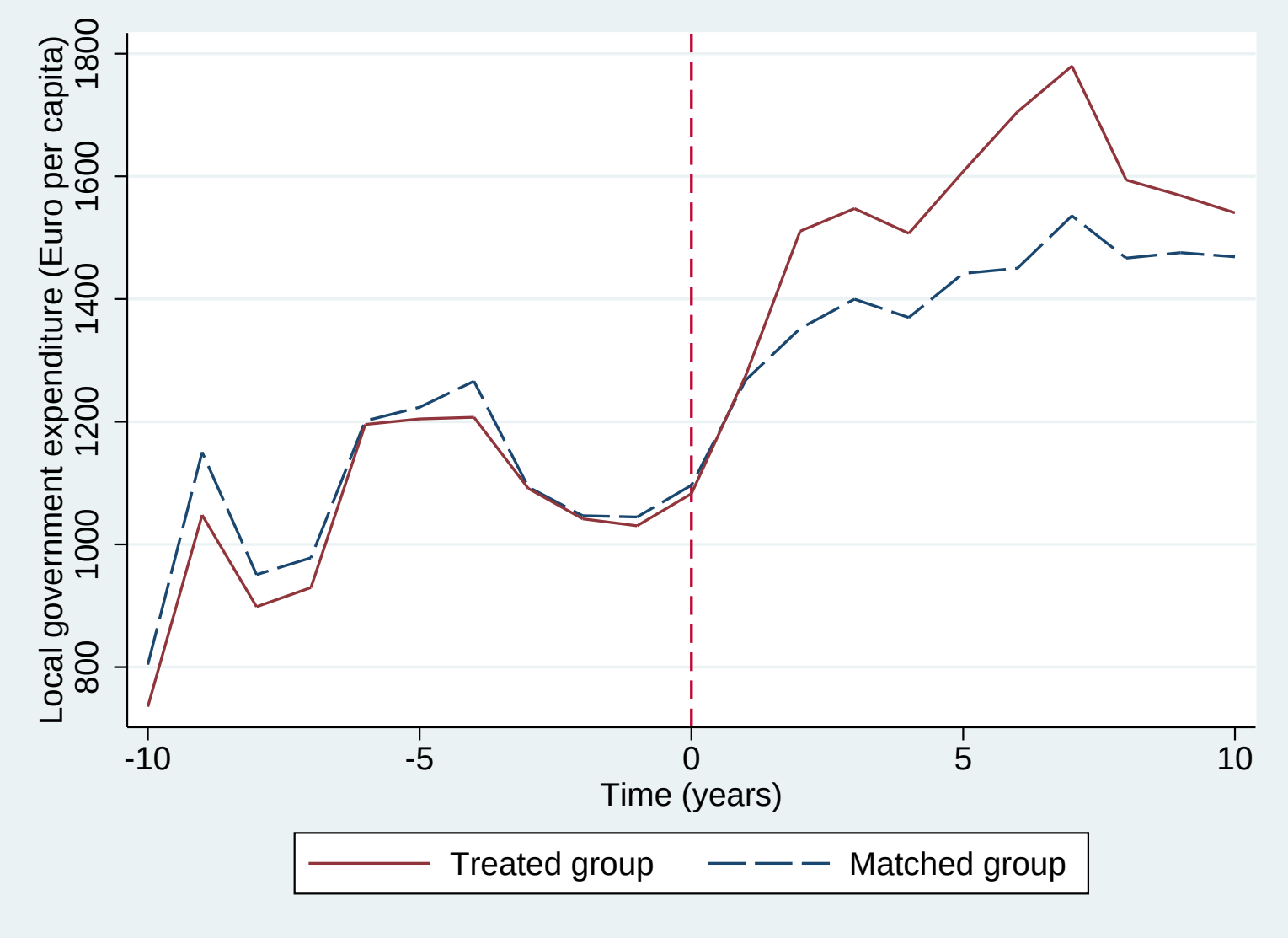
Between 2000 and 2015, **1129 municipalities** were struck at least once.

Other intensity thresholds and magnitude-base earthquake occurrence measures to test the robustness (Appendix).

Suggestive evidence (I)



Suggestive evidence (II)



The group of matched municipalities was built on average pre-earthquake characteristics using coarsened exact matching.

Matching procedure | Balancing properties

Suggestive evidence (III)

	(1)	(2)
	Treated group	
	Before	After
Expenditure p/c	1332.1	1664.1***
Revenues p/c	1674.4	1833.3**
Transfers p/c	623.5	706.2*
Tax revenues p/c	340.9	344.1
Average income	14966.0	15296.9
Population	11714.2	10479.5
N	920	1165
Municipalities	1129	

Stars in column 2 are the results of *t*-tests on mean differences between columns 1 and 2.

Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

Earthquakes and spending levels (I)

List of variables

$$y_{it} = \sum_{j=0}^{11} \alpha_j EQ_{t-j} + x'_{it}\beta + \theta_t + \gamma_i + \varepsilon_{it} \tag{1}$$

$\mathbf{y_{it}}$ = log per capita local government expenditure.

- We use also $\mathbf{y_{it}}$ = log per capita transfers from upper tier governments to investigate the role of grants.

x'_{it} includes funding sources, socioeconomic, sociodemographic, political and environmental characteristics.

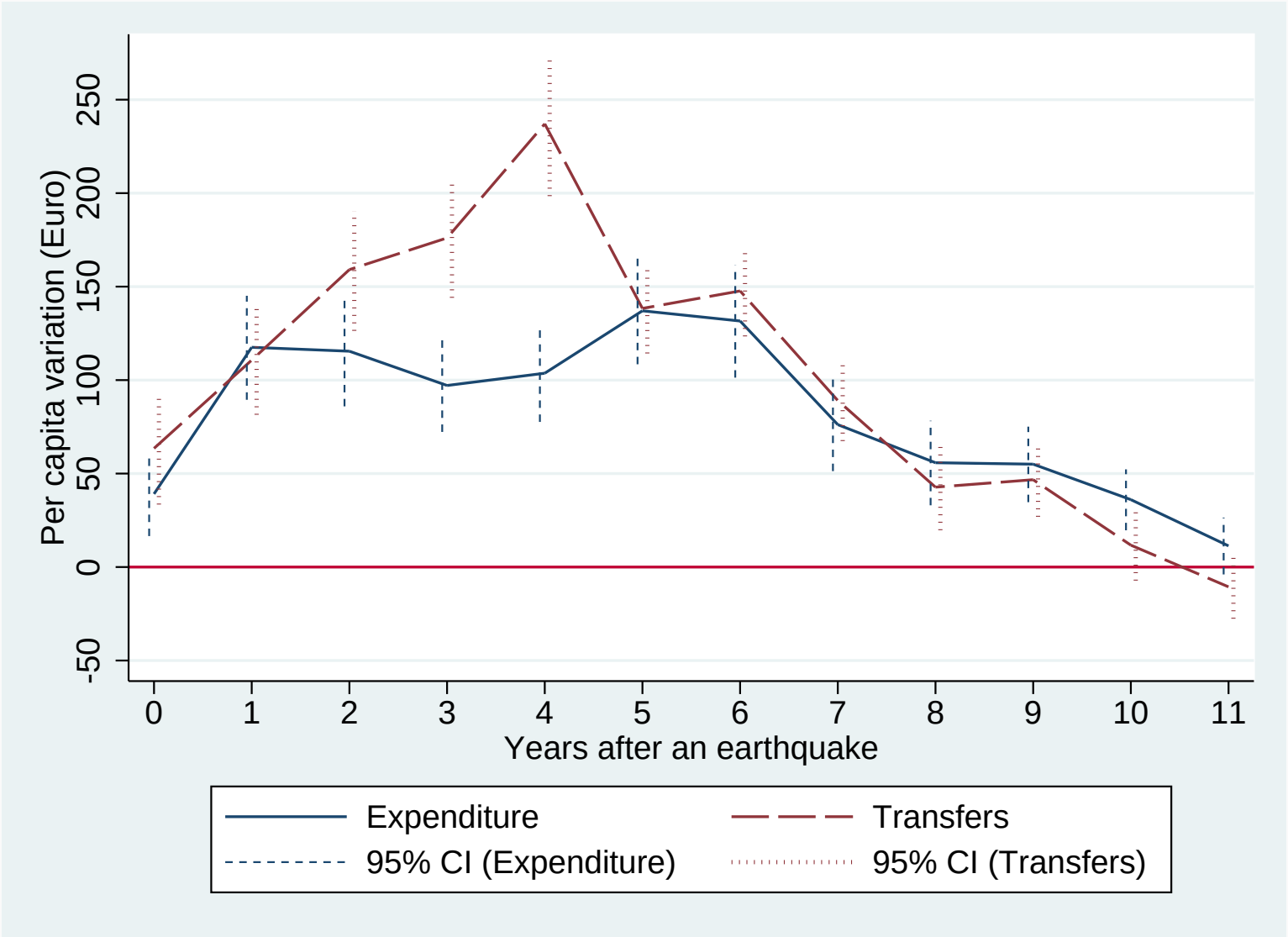
Alternative approach:

$$\begin{aligned} y_{it} = & \sum_{j=0}^{1} \alpha_j EQ_{i,t-j} + EQ_{i,t-d} \times (\alpha_{d1} Dist_{it} + \alpha_{d2} Dist_{it}^2 + \alpha_{d3} Dist_{it}^3) \\ & + x'_{it}\beta + \theta_t + \gamma_i + \varepsilon_{it} \end{aligned} \tag{2}$$

$\mathbf{Dist_{it}} = d$ if $EQ_{i,t-d} = 1$.
$\mathbf{d}$ = temporal distance since the most recent earthquake before $t-1$ ($1 < d \leqslant 15$).

Results and role of grants

Other approach | Regression results table



Heterogeneous and asymmetric response to grants (I)

$$Y_{it} = \alpha_1 MG_{it} + \alpha_2 MA_{it} + \alpha_3 UG_{it} + \alpha_4 UA_{it} + X'_{it}\beta + \theta_t + \gamma_i + \varepsilon_{it} \quad (3)$$

$\mathbf{Y_{it}}$ is the real per capita local government expenditure.

$\mathbf{MG_{it}}$ are estimated earthquake-specific matching grants.[1]

$\mathbf{MA_{it}} = MD_{it}(MG_{it} - MG_{i,t-1})$, with $MD_{it} = 1$ if $MG_{it} - MG_{i,t-1} < 0$.

$\mathbf{UG_{it}}$ are mainly unconditional grants (following Gennari and Messina (2014), Levaggi and Zanola (2003)).

$\mathbf{UA_{it}} = UD_{it}(UG_{it} - UG_{i,t-1})$, with $UD_{it} = 1$ if $UG_{it} - UG_{i,t-1} < 0$.

[1] To predict matching and unconditional grants in struck municipalities after the earthquake, we use average growth rates of (unconditional) grants of the control group build with the matching procedure.

Matching grants

Heterogeneous and asymmetric response to grants (II)

	(1) FE	(2) IV
Earthquake-specific grants	0.294***	0.254**
	(0.0794)	(0.0830)
Asymmetry (Eq.-specific grants)	-0.245***	-0.219***
	(0.0436)	(0.0471)
General grants	0.746***	1.648**
	(0.0445)	(0.588)
Asymmetry (General grants)	-0.336***	-0.0210
	(0.0286)	(0.673)
Income	0.0426***	0.0421***
	(0.00689)	(0.00984)
Observations	111825	103681
Overall R-squared	0.300	0.523
Within R-squared	0.241	0.0188
Between R-squared	0.320	0.648
Municipality fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Controls	Yes	Yes

Endog. var.: *General grants and its asymmetry variable*. Instruments: *first and second lag of transfers received by neighboring jurisdictions*.

North-South divide: Impact of transfers

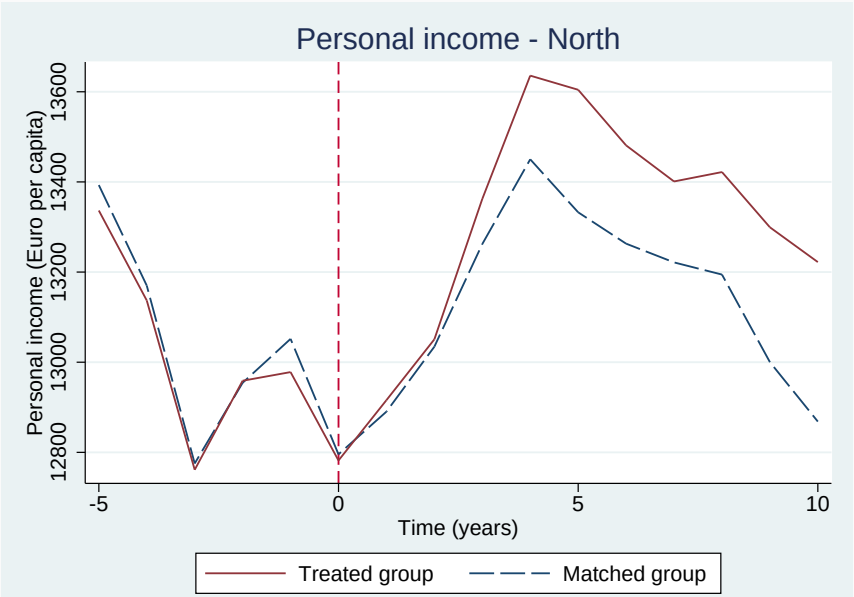
	(1) Full sample	(2) North and Center	(3) South
Earthquake-specific grants	**1.432****	0.679***	0.132**
	(0.487)	(0.132)	(0.0409)
South × Earthquake-specific grants	**-1.205***		
	(0.492)		
Earthquake-specific grants ($t-1$)		**1.103***	**0.156*****
		(0.506)	(0.0372)
Earthquake-specific grants ($t-2$)		**1.393**	**0.306*****
		(0.768)	(0.0435)
General grants	0.646***	0.757***	0.786***
	(0.0572)	(0.0505)	(0.0392)
South × General grants	0.0714		
	(0.0614)		
Income	0.0521***	0.0450***	0.0727***
	(0.00761)	(0.00974)	(0.0208)
Observations	119816	74587	29253
Overall R-squared	0.270	0.393	0.483
Municipality and year fixed effects	Yes	Yes	Yes
Controls	Yes	Yes	Yes

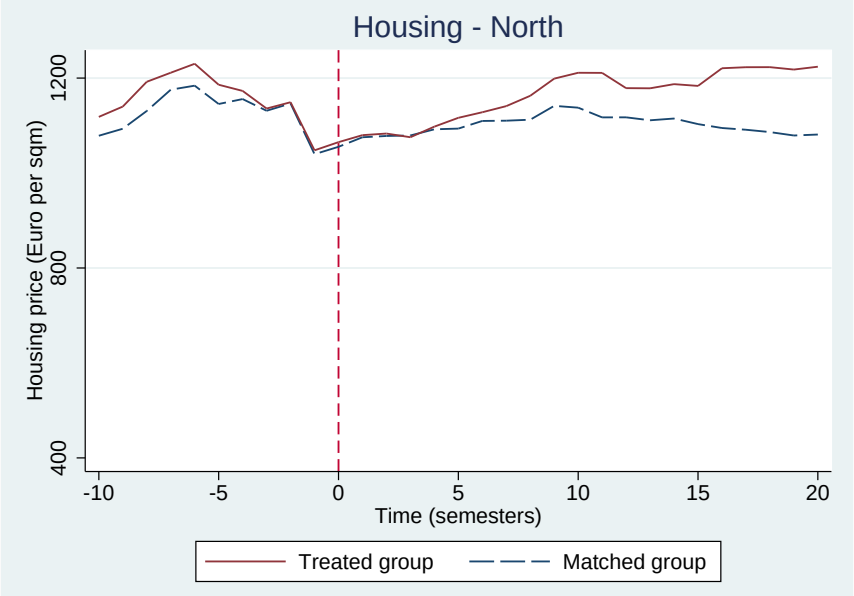
North-South divide: Spending composition after an earthquake

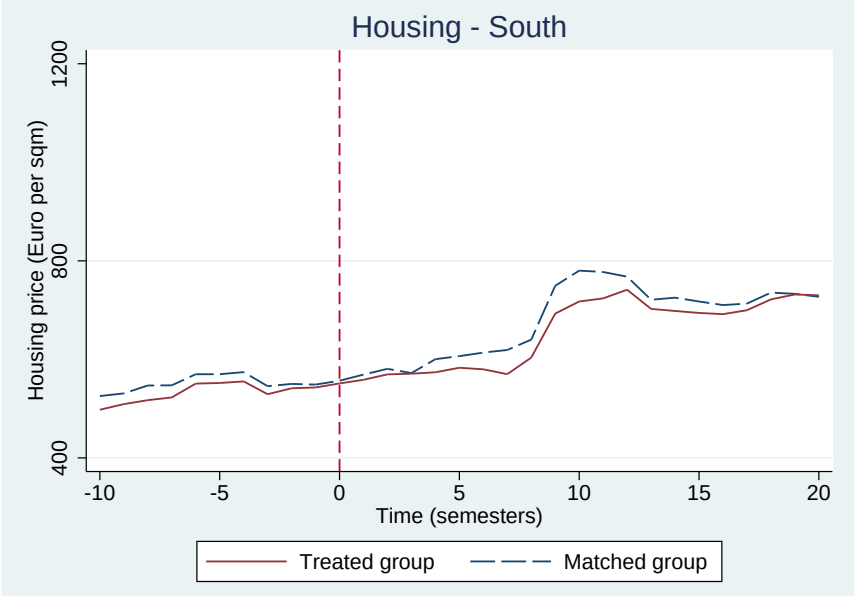
	(1)	(2)	(3)	(4)	(5)
	Before		After		
	North	South	Δ North	Δ South	Δ North - Δ South
Local services	19.34	25.94	2.32***	5.10***	-2.78***
General administration	30.93	32.36	0.96*	-0.80	1.76**
Education	11.02	7.90	-0.84***	-0.32	-0.52
Social protection	11.82	6.72	-1.65***	-0.22	-1.42***
Transport services	13.44	12.25	0.38	-0.65*	1.03**
Other services	13.05	14.75	-0.94**	-3.04***	2.10***
Observations	911	951	3587	2572	

The table reports budget shares (columns 1 and 2) allocated to the main local government spending categories in the five years before a shock (with intensity $\geqslant 5$) and average variations (in %) within five years after the occurrence of the shock (columns 3 and 4). Stars in columns 3 and 4 are the results of t-tests on mean differences before and after an earthquake in the North and South, respectively. Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

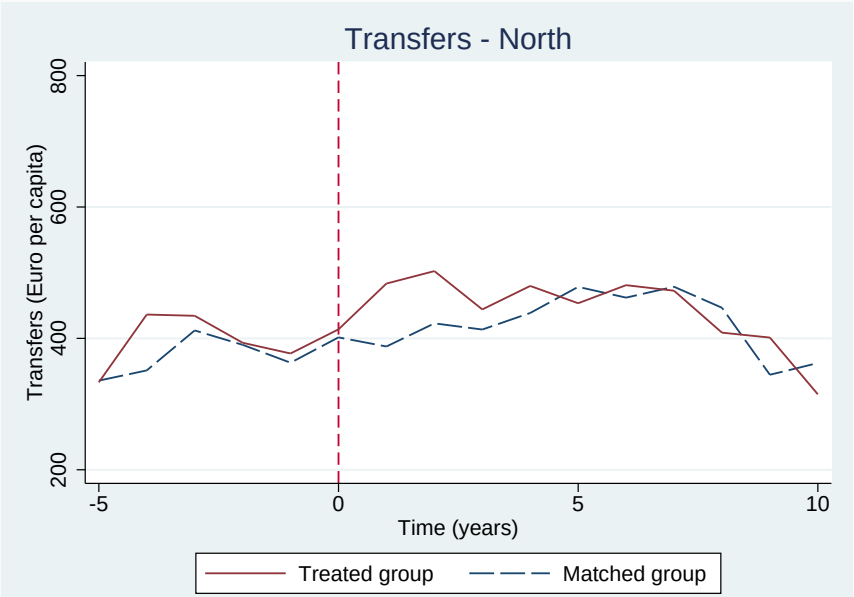
Growth after an earthquake

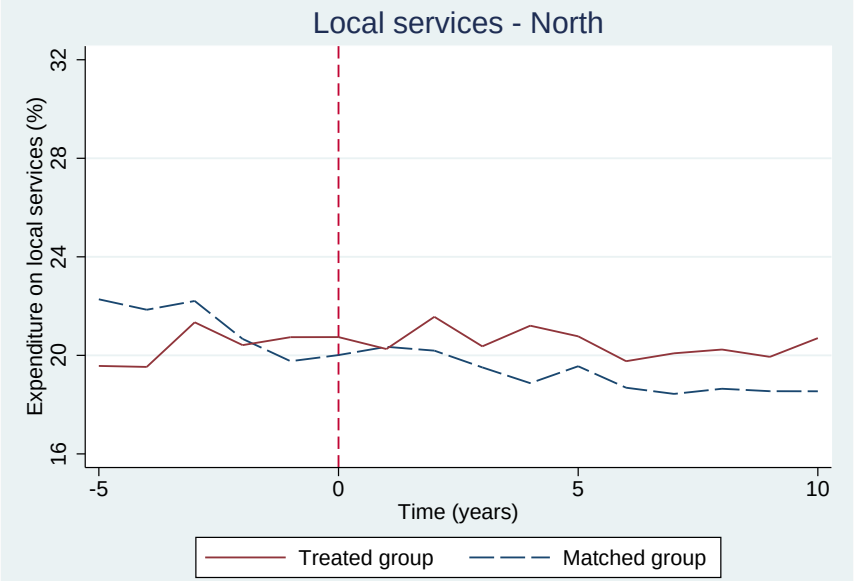


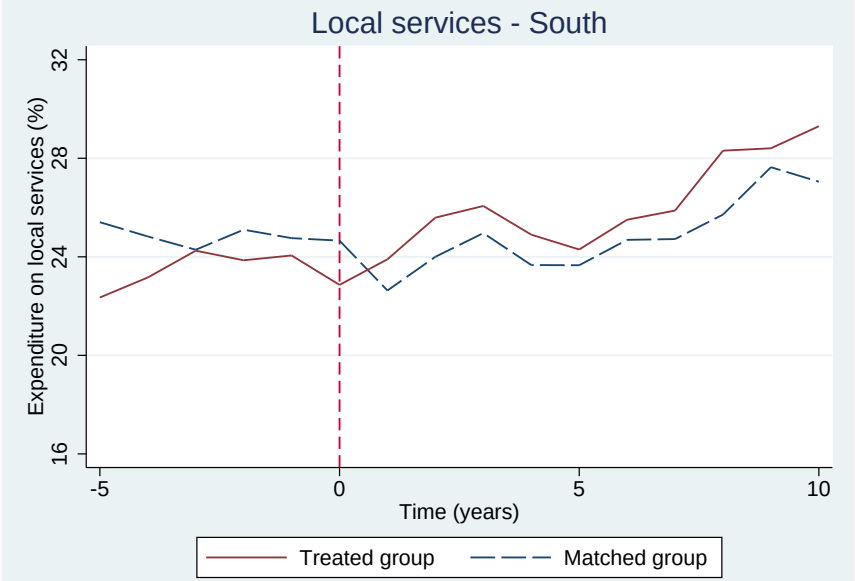




Municipal financial characteristics after an earthquake







Summary and conclusions

Over a 12-year period after an earthquake, affected local governments spend 950 Euro per capita more as compared to unaffected municipalities. Transfers exceed expenditure by 150 Euro per capita.

Evidence of flypaper effect and asymmetric reaction to decreasing grants for both earthquake-specific and unconditional grants.

There is a remarkable North-South divide in the use of resources for recovery.

- Faster recovery and more equal allocation of resources among spending categories in the North $\rightarrow$ capitalization of grants (Allers and Vermeulen, 2016)
- Slow recovery and reallocation to local services $\rightarrow$ rent-seeking of self interested politicians (Brollo et al., 2013, Persson and Tabellini, 2000)

Future research:

- Factors affecting efficient recovery
- Identification of best-practices for recovery

Thanks for your attention!

Appendix

Data

- **Local government balance sheet data** for the period 2000-2015 (Italian Ministry of Interior)
- **Historic registry of earthquakes** occurred in Italy between 1000 and 2014 (DBMI15 and CPTI15 from INGV)
- Personal income data (Italian Ministry of Economics and Finance)
- Sociodemographic and environmental characteristics (ISTAT)
- Local political characteristics (Italian Ministry of Interior)

Control variables

Go back

Funding sources:

- Log per capita transfers from the central and regional government
- Log per capita revenues from local taxation

Socioeconomic characteristics:

- Personal income
- Share of low-income population

Sociodemographic characteristics:

- Share of population aged 0-14 years
- Share of population aged 65 years or above
- Population density

Political characteristics:

- Center-right oriented local government
- Vote share concentration of the mayor
- Last term of the mayor
- Years before ext elections

Environmental characteristics:

- Partial or total mountain jurisdiction
- Coastal jurisdiction

Matching procedure

- Of the 1129 municipalities struck between 2000-2015, we exclude 252 municipalities struck in 2000 because data before earthquake occurrence is not available and drop municipalities with incomplete data for the period 2000-2015.
- We match 743 treated municipalities with 4338 unaffected municipalities that do not share the border with the struck area to build a control group.
- We match on pre-earthquake average characteristics: institutional proximity (same region), transfers from central and regional governments, personal income, population size, budget share allocated to local services, seismic zones and the past cumulative earthquake frequency inversely weighted by time.
- We use coarsened exact matching (Blackwell et al., 2009) and adopt the standard cutpoint algorithm and one-to-one matching.
- We repeat matching for each yearly sub-sample because earthquakes occur at different points in time.
- The matching procedure matched 347 out of 743 treated municipalities.

Balancing properties Go back

Balancing properties of matching procedure

	(1) Treated	(2) Matched	(3) All unaffected
Expenditure p/c	1199.9	1207.4	1509.0***
Transfers p/c	515.4	525.2	549.4***
Income	10639.8	10676.5	11803.6***
Population	5158.1	4892.4	6254.9***
Local services	21.96	22.52	21.74
Seismic zone 1	0.0994	0.0994	0.0581***
Seismic zone 2	0.519	0.519	0.187***
Seismic zone 3	0.306	0.306	0.191***
EQL_{2000}	0.125	0.118	0.0278***
Observations	3458	3458	84967

Matching procedure

Go back

Earthquakes and spending levels

Back

	(1) OLS	(2) OLS (AR1)	(3) IV[1]
EQ_t	0.0194*	0.0190**	0.0139
	(0.00860)	(0.00736)	(0.00934)
EQ_{t-1}	0.0660***	0.0603***	0.0554***
	(0.00976)	(0.00808)	(0.00949)
$EQ_{t-d} \times Dist$	0.0305***	0.0166***	0.0186***
	(0.00398)	(0.00254)	(0.00387)
$EQ_{t-d} \times Dist^2$	-0.00456***	-0.00261***	-0.00253***
	(0.000617)	(0.000405)	(0.000610)
$EQ_{t-d} \times Dist^3$	0.000163***	0.0000966***	0.0000783**
	(0.0000252)	(0.0000170)	(0.0000253)
Observations	119816	119102	112153
Overall R-squared	0.433	0.778	0.457
Municipality fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Controls	Yes	Yes	Yes

[1] Endog. var.: *log per capita transfers from upper-tier governments*. Instrument: *second lag of transfers received by neighboring jurisdictions*. Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Standard errors (in parentheses) are robust and clustered by municipality.

Other models | Matching sample | Different Eq. measures

Earthquakes and spending levels: Other models

	(1) OLS	(2) RE
EQ_t	0.0278**	0.0179*
	(0.0107)	(0.00827)
EQ_{t-1}	0.0651***	0.0632***
	(0.0110)	(0.00945)
$EQ_{t-d} \times Dist$	0.0242***	0.0285***
	(0.00402)	(0.00375)
$EQ_{t-d} \times Dist^2$	-0.00284***	-0.00409***
	(0.000636)	(0.000593)
$EQ_{t-d} \times Dist^3$	0.0000797**	0.000142***
	(0.0000264)	(0.0000245)
Observations	119816	119816
Overall R-squared	0.711	0.675
Region fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Controls	Yes	Yes

Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Standard errors (in parentheses) are robust and clustered by municipality.

Go back

Heterogeneous response to grants: Earthquake-specific grants

Estimation of unconditional and earthquake-specific grants:

- Data on earthquake-specific grants received by local governments is limited and incomplete.
- We use a synthetic control approach using the the control group of not treated municipalities identified by the matching procedure.
- We use the average growth rate of transfers of the control group to predict (unconditional) transfers in struck municipalities if earthquakes would not have occurred.
- Estimated earthquake-specific grants are the difference between grants reported in the balance sheets and estimated unconditional grants.

Matching procedure Go back

Earthquakes and spending levels: Matching sample

	(1) OLS	(2) RE	(3) FE	(4) FE (AR1)
EQ_t	0.0430**	0.0505***	0.0479***	0.0506***
	(0.0139)	(0.0113)	(0.0116)	(0.0101)
EQ_{t-1}	0.0890***	0.100***	0.0993***	0.0905***
	(0.0152)	(0.0137)	(0.0140)	(0.0113)
$EQ_{t-d} \times Dist$	0.0154*	0.0287***	0.0293***	0.0156***
	(0.00625)	(0.00580)	(0.00604)	(0.00363)
$EQ_{t-d} \times Dist^2$	-0.00110	-0.00332***	-0.00344***	-0.00161**
	(0.00103)	(0.000959)	(0.000977)	(0.000599)
$EQ_{t-d} \times Dist^3$	0.00000545	0.0000965*	0.000102*	0.0000373
	(0.0000460)	(0.0000428)	(0.0000431)	(0.0000272)
Observations	18650	18650	18650	18650
Overall R-squared	0.694	0.667	0.463	0.795
Region fixed effects	Yes	Yes	No	No
Year fixed effects	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes

Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Standard errors (in parentheses) are robust and clustered by municipality.

Go back

Earthquakes and spending levels: Different intensity thresholds

	(1)	(2)	(3)	(4)	(5)
	Intensity-based measures		Magnitude-based measures		
	I$\geqslant$6	I$\geqslant$7	D$\leqslant$10 km	D$\leqslant$20 km	D$\leqslant$30 km
EQ_t	0.0555**	0.156**	0.0182*	0.0133**	0.0101**
	(0.0203)	(0.0562)	(0.00914)	(0.00485)	(0.00389)
EQ_{t-1}	0.250***	0.550***	0.0602***	0.0426***	0.0328***
	(0.0262)	(0.0717)	(0.0107)	(0.00549)	(0.00422)
$EQ_{t-d} \times Dist$	0.120***	0.262***	0.0231***	0.0168***	0.00736*
	(0.0102)	(0.0294)	(0.00694)	(0.00384)	(0.00307)
$EQ_{t-d} \times Dist^2$	-0.0165***	-0.0343***	-0.00393**	-0.00301***	-0.000951
	(0.00159)	(0.00425)	(0.00129)	(0.000739)	(0.000611)
$EQ_{t-d} \times Dist^3$	0.000565***	0.00112***	0.000160*	0.000134***	0.0000269
	(0.0000636)	(0.000165)	(0.0000655)	(0.0000390)	(0.0000333)
Observations	119816	119816	119816	119816	119816
Overall R-squared	0.438	0.445	0.441	0.441	0.441
Within R-squared	0.685	0.685	0.681	0.681	0.681
Between R-squared	0.286	0.295	0.291	0.291	0.291
Municipality fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes

Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Standard errors (in parentheses) are robust and clustered by municipality.

Go back

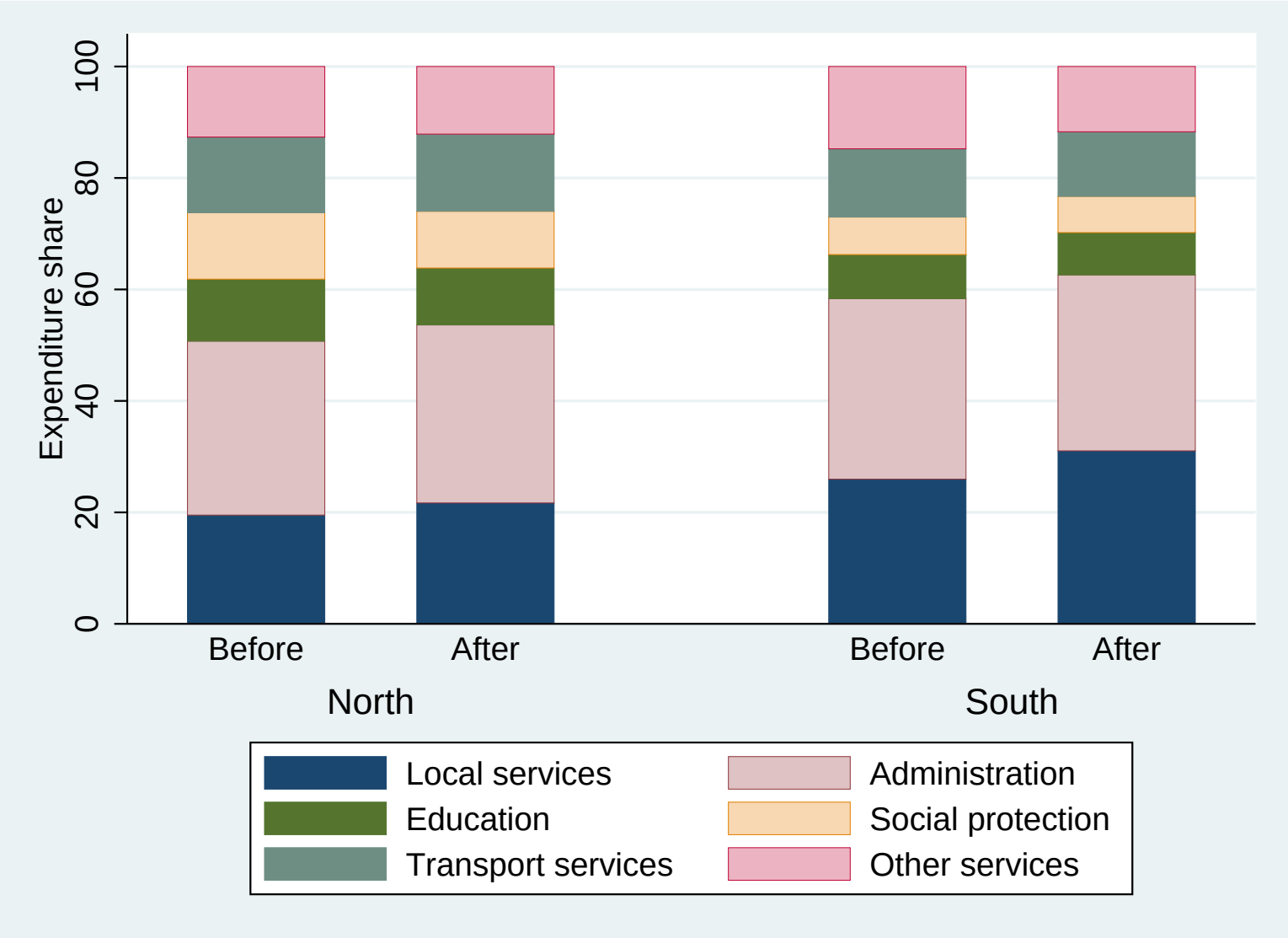
Earthquakes, expenditure and transfers by year

	(1)	(2)	(3)	(4)
	Log		*Euro per capita*	
	Exp.	Transf.	Exp.	Transf.
EQ_t	0.0280***	0.0900***	38.84	62.66
EQ_{t-1}	0.0746***	0.162***	117.2	110.1
EQ_{t-2}	0.0664***	0.206***	114.0	157.7
EQ_{t-3}	0.0616***	0.221***	95.84	174.3
EQ_{t-4}	0.0616***	0.248***	102.7	235.2
EQ_{t-5}	0.0771***	0.196***	135.6	137.5
EQ_{t-6}	0.0688***	0.210***	129.7	146.9
EQ_{t-7}	0.0416***	0.134***	73.49	88.13
EQ_{t-8}	0.0313***	0.0651***	53.43	41.90
EQ_{t-9}	0.0333***	0.0771***	54.28	46.17
EQ_{t-10}	0.0251***	0.0192	36.67	11.41
EQ_{t-11}	0.00791	-0.0189	11.62	-11.03
Observations	119816	119837		
Overall R-squared	0.434	0.121		
Municipality fixed effects	Yes	Yes		
Year fixed effects	Yes	Yes		
Controls	Yes	Yes		

Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$. Standard errors (omitted) are robust and clustered by municipality.

Go back

North-South divide: Spending composition



Source: Our elaboration on data from the Italian Ministry of Interior.

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